IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	:	Customer Number: 45462
Deyang Hou,	:	
Application No. 10/597,000;	:	Group Art Unit: 3752;
Filed: June 12, 2008	:	Examiner: JONAITIS, JUSTIN

For: MIXED-MODE FUEL INJECTOR WITH A VARIABLE ORIFICE

PATENT APPLICANT'S APPEAL BRIEF IN RESPONSE TO FINAL OFFICE ACTION

To:
Board of Patent Appeals and Interferences
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Table of Contents

(i) Statement of the real party in interest

Deyang Hou.

(ii) Related Appeals and Interferences

This appeal should replace the appeal filled on May 21, 2011 for patent application 10/597,000. The May 21, 2011 filing, which has a EFS ID 10141922 and Time stamp 23:58:22, did not contains all necessary parts for appeal brief. Thus, the appellant requests disregarding of the May 21, 2011 filing.

(iii) Status of Claims

All claims 1-23 are rejected by examiner.

Claims 1-10, 13-16, 18, 23 are being appealed.

(iv) Status of Amendments

An amendment after final rejection was filed on May 22, 2011, which has not been acted upon by examiner yet.

(v) Summary of Claimed Subject Matter

For independent claim1, Please refer to paragraph 1 of DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS in the Specification, which is in the page 9 of the office action response filed on May 8th, 2010:

"The mixed-mode fuel injector is a high-accuracy couple of components with a needle valve (1 in FIG. 2), which has a conical head for guiding fuel sprays, which has an opening and a biased closing position, which is movable back and forth and received in a nozzle body (5 in FIG. 2). The fuel injector has a micro-variable-circular-orifice (MVCO) (FIG. 2) comprising of a variable annular ring aperture (4) between said needle valve (1) and said nozzle body (5) and multijet-orifices (6) inside the nozzle body (5) closing to the nozzle body tip (FIG.1, FIG.2, FIG. 3). Said needle valve is received in said nozzle body and has a biased closing position and an opening position decided by driving means such as actuators. When said needle valve is at its opening positions, fuel is discharged through said orifices. *By lifting the said needle valve at predefined magnitudes, the needle valve can partially or completely block the annular aperture (4), thus fuel can be injected as hollow conical spray through the annular aperture at small needle lift or conventional multijet sprays through the multijet-orifices when the needle head blocks the annular aperture (4) at large needle lift.* The fuel injector is capable of generating variable mixed-mode sprays of conical and multi-jet shapes (FIG. 4), whereby generating a major circularly homogeneous conical spray at low to medium loads, and variable mixed-mode fuel sprays at high loads to ensure homogeneous atomization and sufficient penetration. Depending on the location of the multijet-orifices and whether the multijet-orifices are open channels or closed channels simply like conventional nozzle-holes, it

can form different versions of spray shapes to satisfy different needs of penetration and atomization. “

(vi) Grounds of Rejection to be Reviewed on Appeal

Claim Rejections – 35 USC § 112;

Whether claims 1, 2, &17 are unpatentable under 35 USC 112, first paragraph, as being based on a nonenabling disclosure

Whether claims 1-22 are unpatentable under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Cliam Rejections – 35 USC §102

Whether claims 1-4, 5, 8, 14-16, 18 and 21-22 are unpatentable as being anticipated by Japanese Patent #JP10-299613 to Date.

Whether claims 23 are unpatentable as being anticipated by U.S. Patent #3,042,317 to Simmons.

Claim Rejections – 35 USC 103

Whether claims 6, 7, 9-10, and 20 are unpatentable over Japanese Patent #JP10-299613 to Date.

Whether claim 11-13 are unpatentable if remove the multiple dependent to become dependent of claim 2 only.

(vii) Argument

Summary: The Appellant argues that, after cancelling claims 11-12, 17, 19-22, all the rest of claims are patentable, that is, claims 1-10, 13-16, 18, 23 are patentable.

Drawings:

1. Drawings are extended to address every feature in claims as suggested by examiner.

2. 2.1 The conical surface being a diverging curve surface of claim 5 is shown in FIG. 6;

   2.2 The conical surface with 2 conical surfaces of claim 4 is shown in FIG. 5.

   2.3 Plurality of multijet orifices being on the conical surface of claim 7 as well as the various orifice types (semi-circular, arcs, triangles, trapezoids, etc) are shown in FIG. 7;

   2.4 The variable circular aperture of claim 15 is shown on FIG. 9 (a), the diagrams of flow during low to medium loads and flow during high loads of claim 15 are shown in FIG. 9 (a) & (b), respectively.

   2.5 The diagrams for claim 13, where multijet-orifices (6) are distributed on or under the conical surface (C) so that they can be open channels (FIG. 8b) or closed channels (FIG. 8a) are shown in FIG. 8.

   2.6 The diagram of claim 14 is shown in FIG.10, in which a mixed-mode fuel injector has a plurality of multijet-orifices underneath the said conical surface (C), forming a sac-hole (FIG. 10a) or valve-covered-orifice

multi-hole type (FIG. 10b) injector through blocking the circular aperture by the needle head at a predefined needle-lift range.

Response to Claim Objections:

3. Claim 11-12 are cancelled. Claim 13 can be amended such that it *depends on claim 2 only*. Thus, no new matter is added, multiple dependent is removed.

4. Claim 19 is cancelled.

Response to Claim Rejections – 35 USC § 112

5. Refer to first paragraph of 35 U.S.C. 112.

6. Claim 17 is cancelled, so any confusions between claims 1, 2 and 17 should be eliminated. The applicant has two tele-conferences before with the Examiner and Examiner's supervisor. The technical contents for claim 1 & 2 has been clarified and agreed upon as in interview documents. The suggestions from examiner have been incorporated into previous amendment. So the rejections for claim 1 & 2 based on 35 U.S.C. 112 are not anticipated. Claim 1 &2 contains sufficient details to comply with the enabling requirement.

7. Refer to second paragraph of 35 U.S.C.112.

8. The inventions were clearly pointed out in claim 1, 2, 13, 14, 15, 16 and rest of the claims 3-10, 18, 23. The Conical Surface (C) is clearly marked on FIG 2. The definition of this Conical Surface applies to all claims. There are two major design options for the multijet-orifices – that 'ON the conical surface' (C), as stated in claim 7, and is shown in FIG. 7 (a) & (b); that

'underneath the conical surface' (C), as stated in claim 13, 14, and is shown in FIG 8 (a), FIG. 9 (a) & (b), FIG. 10 (a) & (b). The Examiner's interpretation of the conical surface being the needle seating surface (2) is not correct. The seal surface (2) is clearly marked in FIG. 2 and stated in claim 1, which is obviously different from the Conical Surface (C). The specific combination of orifice structure, needle lift magnitude and spray patterns, as stated in claim 1-10, 13, 14, 15, 16, 18, 23 has not been disclosed in any previous art. They are the key inventions for this application. Thus, claims 1-10, 13, 14, 15, 16, 18, 23 are patentable under 35 U.S.C. 112, second paragraph.

9. *Please refer FIG. 6. Such a curved surface (C) feature is not presented in previous arts. The curved surface is still can be considered as bearing conical feature. Thus Claim 5 is patentable.*

Response to Claim Rejections – 35 USC §102

10. *Please refer to 35 USC §102 quotation as in the Office action document.*

11. *Claims 1-4, 5, 8, 14-16, 18 stands, as they produce different spray patterns during the needle lift process with a different orifice structure. More specifically, in Date's design:*

- *Small needle lift – produces multiject spray;*
- *Middle level needle lift – produces hollow conical – multijet spray;*
- *Large needle lift – produces hollow conical spray; can still be hollow conical – multijet spray depending on needle lift;*

In contrast, in Hou's 10/597,000 design:

- *Small needle lift – produces hollow conical spray;*
- *Middle level needle lift – produces hollow conical – multijet spray;*
- *Large needle lift – produces multijet spray;*

Also, Gate did not give any other designs such as multijet orifice ON the conical surface (C), Date did not give flow guide conical surface (C), Gate did not give a simple and smooth needle head curvature design as Hou did, as shown in FIG. 2.

Hou's design significantly improves the fuel injection adaptability and performance. In contrast, Date's design produces a spray pattern that is exactly what we want avoid in practical applications. Also, Gate's design has a section of guide (33) which is a significant concern of reliability for operation, since matching two surfaces(33 & 30 in Gate's FIG. 3) with small clearance in high speed needle open-closing operation is a very challenging task. In contrast, Hou's design does not have Gate's above feature. Hou's design significantly improves the reliability and capability for practical applications. Further, in Hou's design, the needle surfaces close to needle head are much simple and smooth curvatures which benefits guiding the fuel flow and reduces friction loss. The needle (6) in Gate's design does not have this smoonth curvature feature.

12. *What Simmons disclosed in U. S. Patent #3,042,317 is a mechanical puppet valve, which was manually activated by screws, it's a far different concept than Hou's invention disclosed here. Simmons's invention was related to an 'outward opening' valve, the sealing surface (15) in*

#3,042,317's FIG 1, is outside the nozzle body, which is completely different than Hou's invention, which is an 'inward opening' valve, and the sealing surface, (2) in Hou's FIG 2, is inside the nozzle body. Thus claim 23 is not anticipated by U.S. Patent #3,042,317.

Response to Claim Rejections – 35 USC 103

13. *Since Hou's invention produce different spray patterns in different sequence than Date's invention, Hou's invention bears significant advantages for advanced combustion, as already discussed in above. It is not an obvious matter to change spray pattern varying sequence to fit for needs of advanced combustion. Thus, the rejections of claims 6, 7, 9-10 under 35 U.S.C. 103 (a) over Gate's JP10-299613 does not apply.*
14. *Claim 20 is canceled.*
15. The Appellant argues that, after cancelling claims 11-12, 17, 19-22, all the rest of claims are patentable, that is, claims 1-10, 13-16, 18, 23 are patentable.

The applicant has searched the related patents listed by patent examiner, and fund none of the prior art can give variable spray patterns including a hollow conical spray and multijet spray, in the given sequence, through a single injector with a single needle valve as defined in the patent application 10/597,000. The applicant believes that the said injector is unique and bears inventions and merits not provided by prior arts, it's applicable for industrial applications.

Respectfully submitted,

/Deyang Hou/

May 22, 2011

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(viii) Claims Appendix

Claims

1. (Rejected) A mixed-mode fuel injector comprising:

(i) a nozzle body (5) comprising passages for fuel (FP), an inner cylindrical space for receiving a needle valve (1), and a conical surface (C) close to the tip (7) of the nozzle body for guiding a spray of fuel;

(ii) a needle valve (1), which has a converging-diverging conical head for guiding a spray of fuel and which is movable back and forth and received in said nozzle body, wherein said needle valve is at a biased closing position with its seal surface (2) being pressed against nozzle body (5) to block fuel flow, or an opening position defined by driving means through lifting the said needle valve seal surface away from nozzle body; and

(iii) a micro-variable-circular-orifice comprising a variable annular ring aperture (4) between said needle valve and said nozzle body which has means of producing hollow conical spray, and at least one conventional multijet-orifice (6) inside the said nozzle body (5) which has means of producing at least one conventional jet spray, such that fuel is dischargeable in variable sprays of hollow conical and multiple jets shapes through said micro-variable-circular-orifice and multijet-orifice by lifting said needle valve at different magnitudes.

2. (Rejected) A mixed-mode fuel injector according claim 1, wherein the micro-variable-circular-orifice further comprises a plurality of multijet-orifices (6).

3. (Rejected) A mixed-mode fuel injector according to claim 1 or 2, wherein the conical surface (C) has a single conical surface.

4. (Rejected) A mixed-mode fuel injector according to claim 1 or 2, wherein the conical surface (C) is an integrated conical surface having two or more conical surfaces with different conical angles connected together.

5. (Rejected) A mixed-mode fuel injector according to claim 1 or 2, wherein the conical surface (C) is a diverging curved surface.

6. (Rejected) A mixed-mode fuel injector according to claim 1 or 2, wherein the needle lift for the opening position is approximately in the range of 0-300μm, the needle head diameter is approximately in the range of 0.8-3.5mm, and the angle between the centerline of the nozzle body (5) and the inner conical surface (C) at the nozzle body tip (7) is approximately in the range of 35-75 degree.

7. (Rejected) A mixed-mode fuel injector according to claim 2, wherein the plurality of multijet-orifices (6) is on the said conical surface (C) with cross sections that are one or more of semi-circles, arcs, triangles, trapezoids or other polygons.

8. (Rejected) A mixed-mode fuel injector according to claim 2, wherein the needle head (3) remains at least partially received within the tip (7) as the needle valve (1) is moved back and forth between the biased closing position and opening position such that when fuel is injected through the micro variable aperture (4) between the needle head and said conical surface of the nozzle body, fuel is also injected through the multijet-orifices *(6)*, the upper surface of the needle head and the conical surface serve as guiding surfaces for fuel sprays.

9. (Rejected) A mixed-mode fuel injector according to claim 7, wherein there are about 4-20 multijet-orifices with the cross-section of semi-circles with the diameters approximately in the range of 50-300μm.

10. (Rejected) A mixed-mode fuel injector according to claim 7, wherein there are about 4-20 multijet-orifices (6) having a cross-section other than semi-circles with the maximum dimension approximately between 50-400μm.

11. (Rejected A mixed-mode fuel injector according to any of *claims 2 to 10*, wherein the sizes of said multijet-orifices (6) are the same.

12. (Rejected) A mixed-mode fuel injector according to any of *claims 2 to 10*, wherein the sizes of the multijet-orifices (6) are different depending on specific needs of atomization.

13. (Rejected) A mixed-mode fuel injector according to any of *claims 2 to 10*, wherein the said multijet-orifices (6) are distributed on or under the conical surface (C) so that they can be open channels or closed channels.

14. (Rejected) A mixed-mode fuel injector according to claim 2, has a plurality of multijet-orifices underneath the said conical surface (C), forming a sac-hole or valve-covered-orifice multi-hole type injector through blocking the circular aperture by the needle head at a predefined needle-lift range.

15. (Rejected) A mixed-mode fuel injector according to claim 2, wherein different shapes of fuel sprays are generated by changing the magnitude of lift of said needle valve (1) and the needle

valve is arranged within the nozzle body (5) so that, at low to medium injection loads, fuel is mainly injected through the variable circular aperture between the needle head (3) and_conical surface (C) of nozzle body (5) by a small needle lift, thus mainly forms a conical shape spray, while at high injection loads, fuel is injected through both the variable circular aperture between the needle head and nozzle body and the multijet-orifices (6) by a larger needle lift, thus forms a mixed-mode conical-multi-jet shape spray, whereby provides different atomization desired by engine combustion at different loads.

16. (Rejected) A mixed-mode fuel injector according to claim 2, wherein different shapes of fuel sprays are generated by changing the magnitude of lift of said needle valve (1) and the needle valve is arranged within the nozzle body (5) so that, at low to medium injection loads, fuel is mainly injected through the variable circular aperture between the needle head (3) and conical surface (C) of nozzle body by a small needle lift, thus mainly forms a conical shape spray, while at high injection loads, the needle head can completely or partially block the variable circular aperture by a large needle lift, whereby fuel is fully or mainly injected through the multijet-orifices (6), which can be open channels or closed channels depending on penetration needs, thus mainly forms conventional multi-jet sprays at high loads, whereby provides different penetration desired by engine combustion at different loads.

17. (Rejected) A mixed-mode fuel injector according to claim 1 or 2, wherein the fuel channel between the needle valve (1) and the nozzle body (5) is of converging-diverging shape and by lifting said needle valve at different magnitudes, the minimum cross-section is at the sealing surface (2) during the early stage of fuel injection, the minimum cross- section is at said micro-variable-circular-orifice or at the sealing surface (2) during the middle stage of fuel injection, and the minimum cross-section is at the sealing surface (2) again during the late stage of fuel injection, whereby it has means of ensuring fine atomization during all fuel injection stages.

18. (Rejected) A mixed-mode fuel injector according to claim 1 or 2, wherein the angle between the centerline of the conical surface (C) and the centerline of the nozzle body (5) is approximately 0-15 degrees, depending on an angle between a centerline of the fuel injector and a centerline of a piston in an engine cylinder.

19. (Rejected) A mixed-mode fuel injector according to any of the preceding claims, wherein the fuel injected is one or more of diesel fuels, gasoline fuels, alternative fuels, mixtures of water and fuels, pure water or liquid exhaust cleaning additives wherein the fuel injector is a general purpose injector.

20. (Rejected) A mixed-mode fuel injector according to claim 1, wherein the needle valve (1) is passively driven by high fuel pressure which provides said driving means.

21. (Rejected) A mixed-mode fuel injector according to claim 1, wherein the needle valve (1) is actively driven by an actuator which provides said driving means.

22. (Rejected) A mixed-mode fuel injector according to claim 21, wherein the actuator is a solenoid or a piezo actuator.

23. (Rejected) A mixed-mode fuel injector, which has a micro-variable-circular-orifice (MVCO) comprising a variable annular ring aperture as in claim 1, wherein the MVCO is used as a sole orifice or in-combination with other multi-hole conventional orifice wherein fuel is injected through multiple channels in multi-jets into combustion chamber.

(ix) Evidence Appendix

None.

(x) Related Proceedings Appendix

None.

DRAWINGS

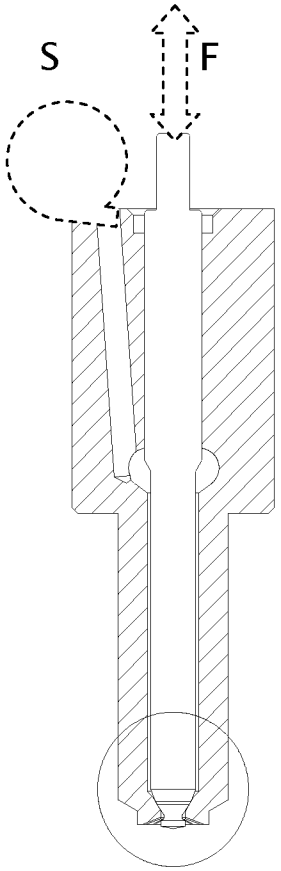


Fig. 1

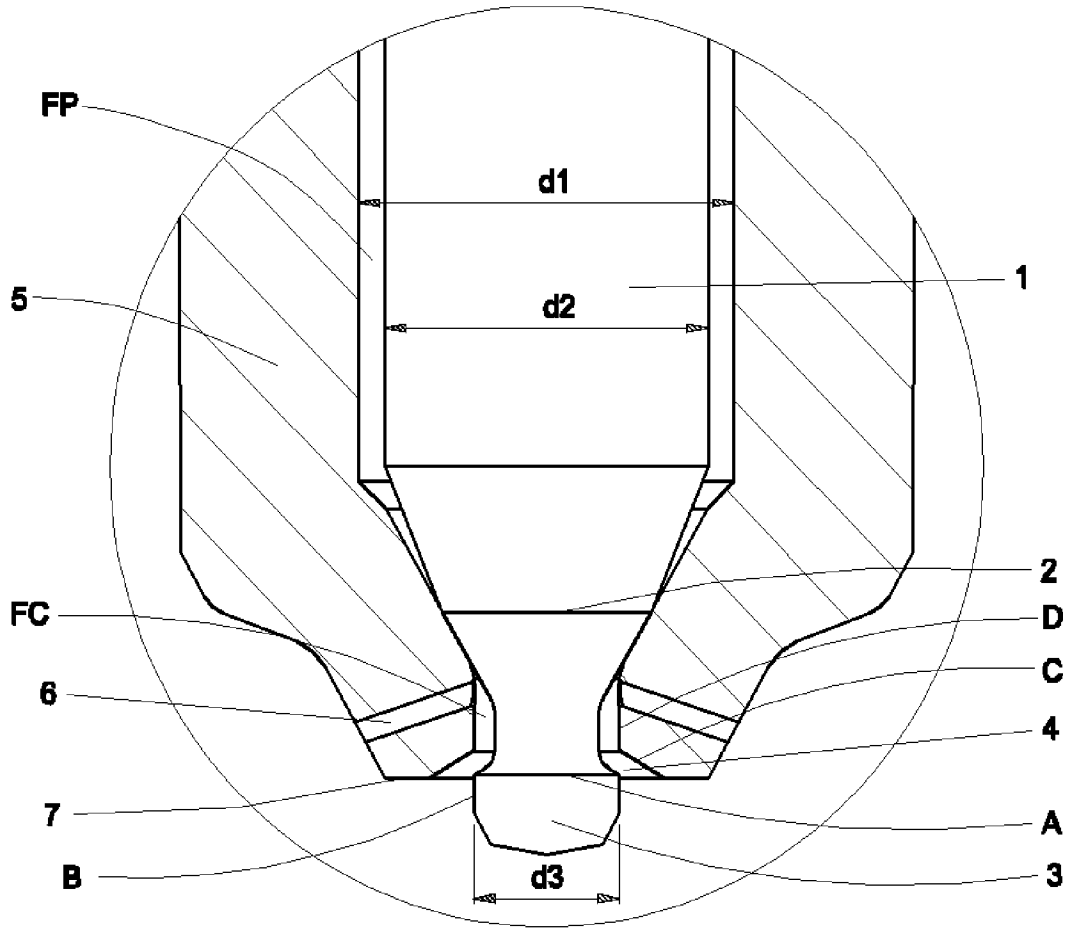
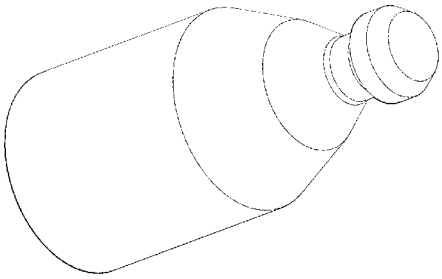
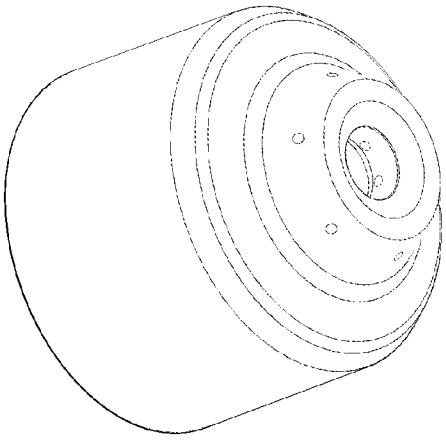


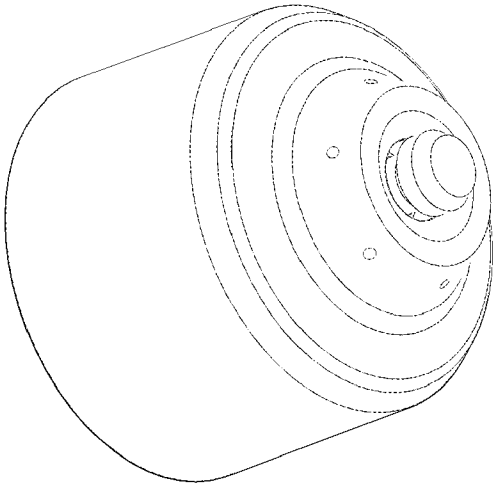
Fig. 2



(a)



(b)



(c)

Fig. 3

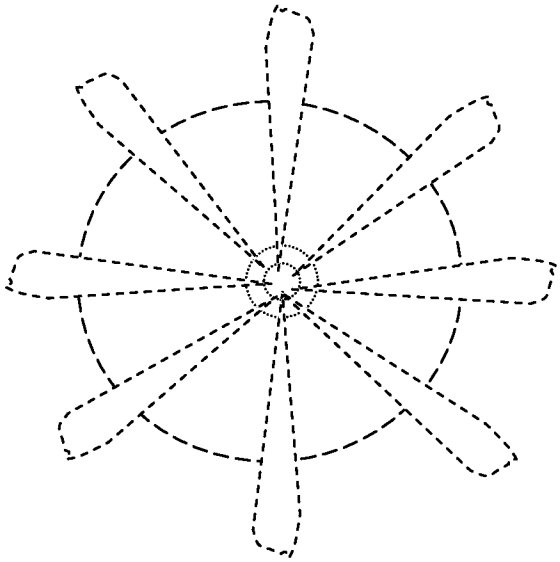


Fig. 4

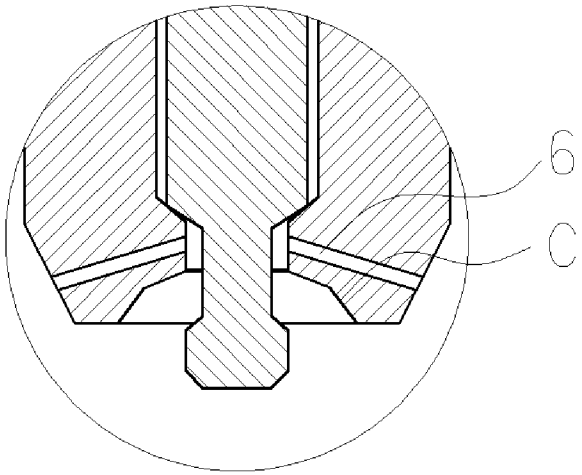
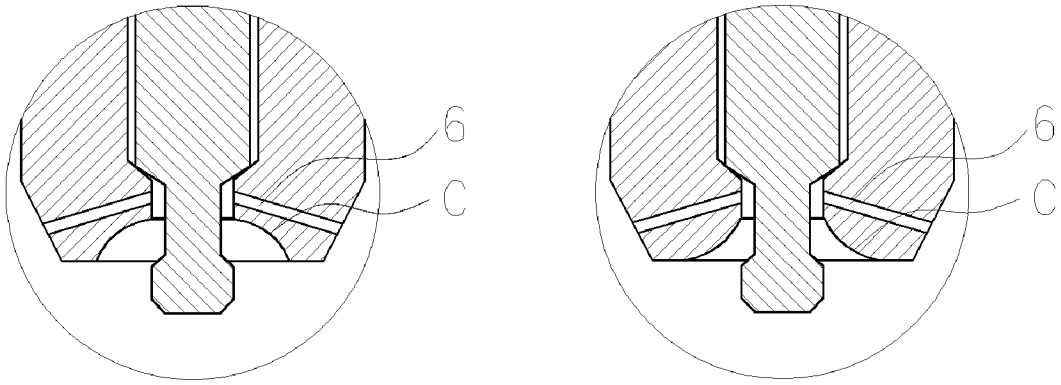
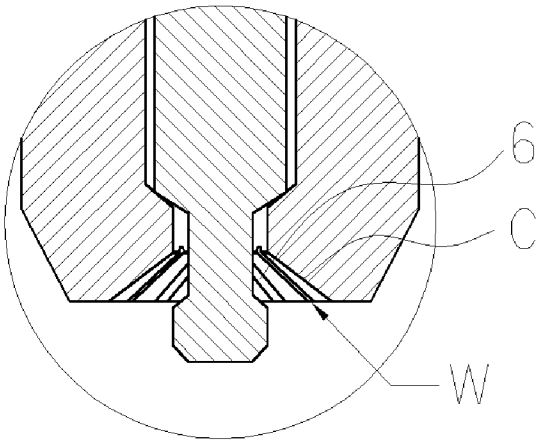


Fig. 5



(a) (b)

Fig. 6



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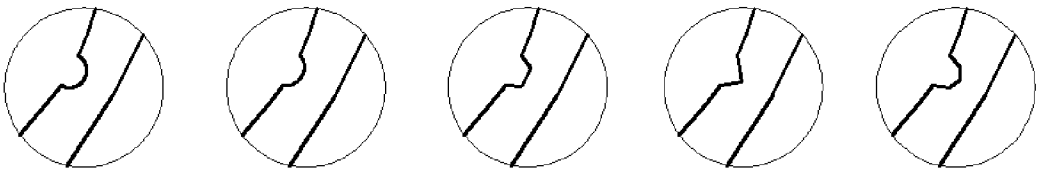

(b)

Fig. 7

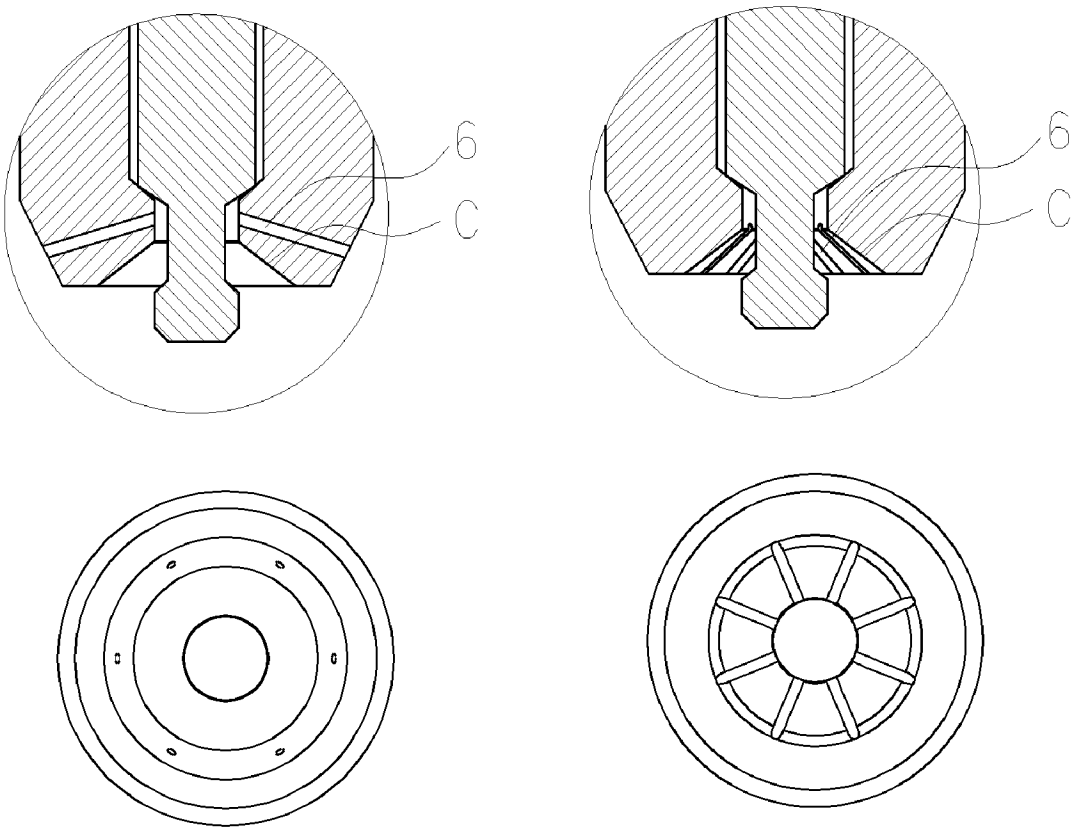

Fig. 8

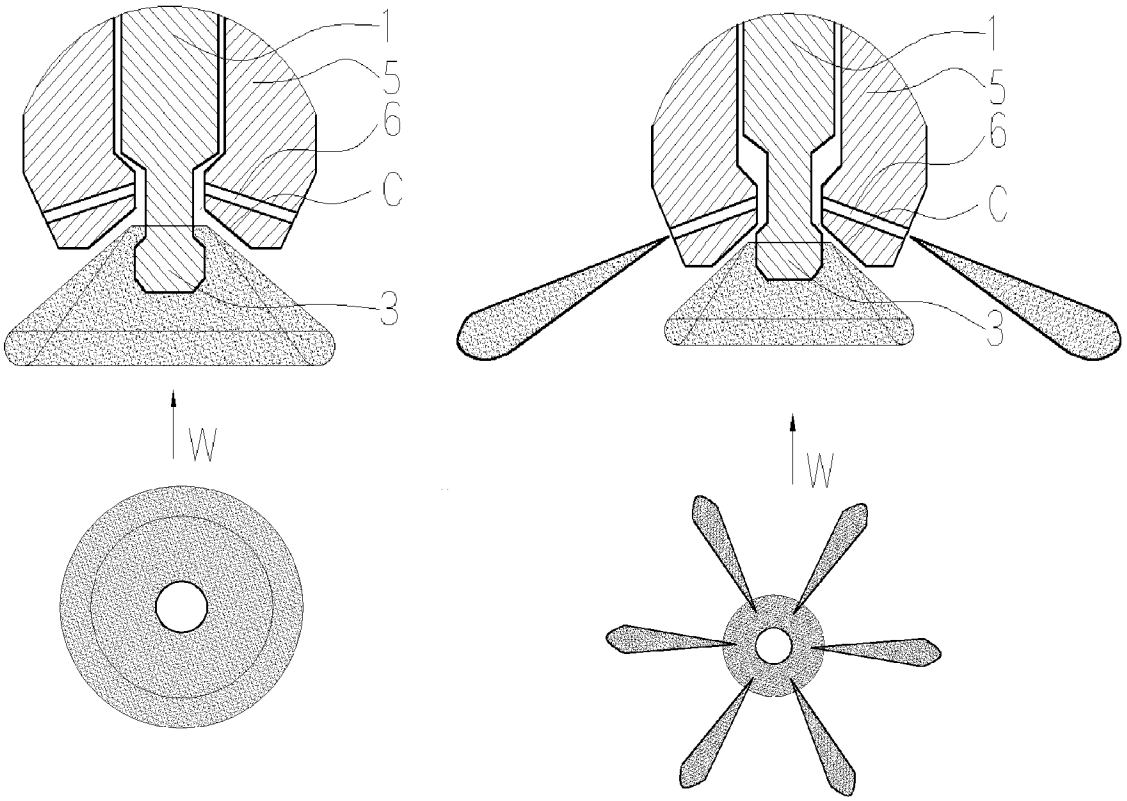

Fig. 9

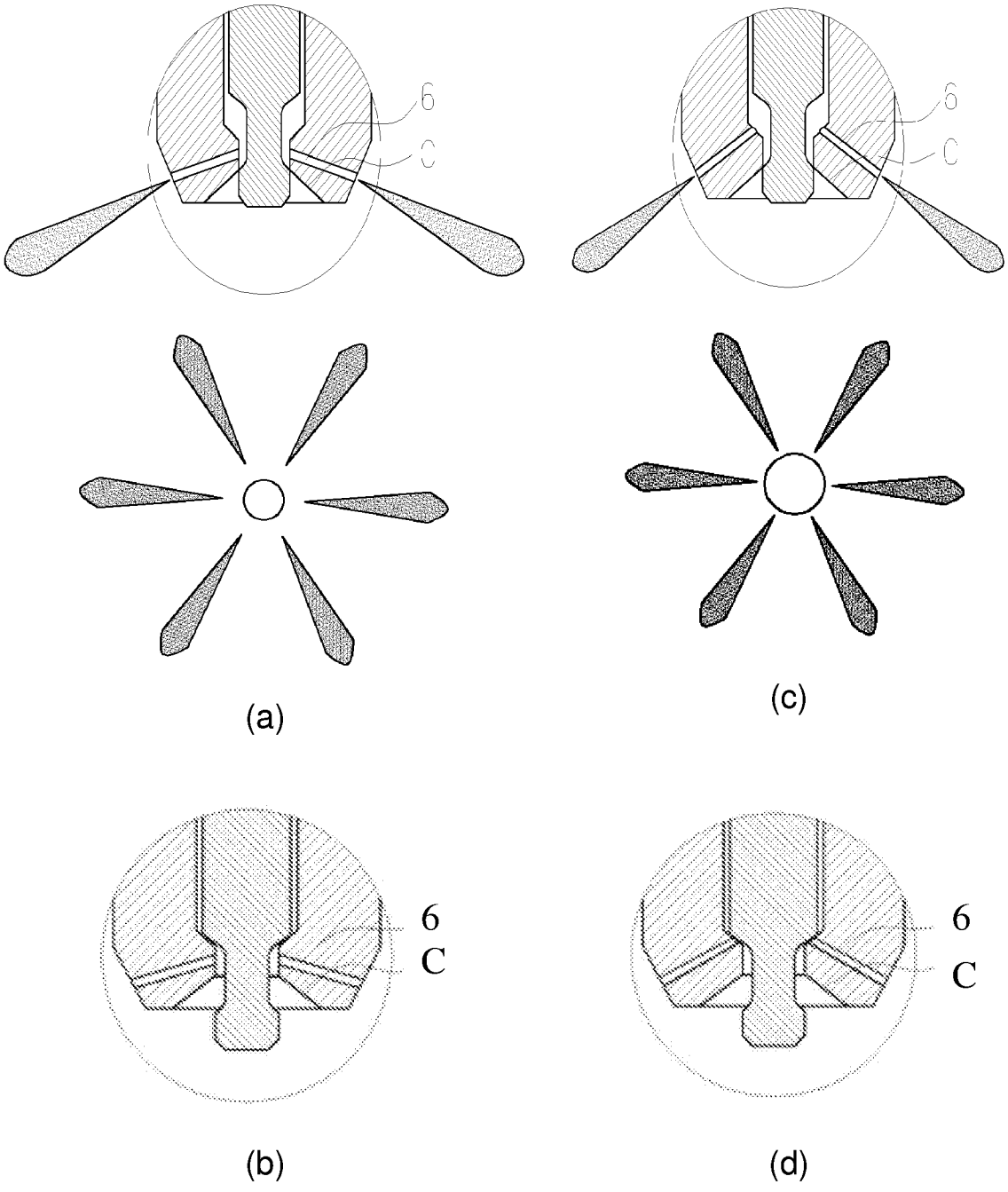

Fig. 10